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(54) IMPROVEMENTS IN OR RELATING TO WEIGHING DEVICES

(71) We, TRANCON AB, a Swedish body Corporate of Lidmansvagen 7, 724 61 Vasteras, Sweden, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a device for static or dynamic weighing of rail-guided vehicles such as railway wagons, trucks of different kinds, trams, hoists, overhead cranes and hopper cars.

It is known that vehicles on rails can be weighed by means of platform scales, arranged in weighing pits in the path of the vehicle. One example of such a scale for railway wagons is shown, for instance, in a pamphlet from Toledo called Toledo Steel Master Levers printed in the U.S.A. by Toledo Scale Corporation, Toledo, Ohio 43612. On the upper surface of the platforms a rail of some kind, for instance a channel beam for a rubber wheel or a railway rail for railway car wheels is arranged, with its upper surface in the same plane as the upper surfaces of the fixed rails outside the scale, but disconnected from the fixed rails by an open joint at each end, so that the rail section carried by the scale is free to move vertically. The load is sensed by means of, for instance, a mechanical weighing system or load cells.

For weighing railway cars in particular, a large number of devices are known which are based on the principle that a section of the rail system contains some kind of stationary scale sensing the load *via* the upper surface of the rail, or *via* another rail replacing the main rail.

Examples of such known devices are found in the British Patent Specification Nos. 820,969, 797,161 and 832,389 and other forms are shown in U.S. Patent Specification No. 3,085,642, German Patent Specification No. DT 1,079,338, French Patent Specification No. 1,292,587 and 974,974 and Swedish Patent Specification No. 217,810. All of these known devices require extensive and expensive scale foundations.

When high weighing accuracy is needed, the foundations have to be very deep and long, and the weighing devices are normally provided with force shunting tie bars which cause part of the load to by-pass the load sensing means and be led to the foundations. This part of the load is thus not measured by the load sensing means. Furthermore, the weighing devices must be dimensioned to withstand even extreme horizontal loads, which probably occur rarely. This means that force shunting effects causing part of the load to by-pass the load sensing means may be relatively large.

Force shunting due to bending of tie bars is not constant, but varies because of variations in the movement of a vehicle supporting portion disposed between load supporting surfaces of a load sensing means or because of variations in the deflection of a vehicle supporting portion for the same load but different positions of the load on the vehicle supporting portion. This causes changes in the force shunting effect and, accordingly, errors in the weighing system.

Other devices for weighing rail-guided vehicles shown in Swedish Patent Specification No. 217,810 and British Patent Specification No. 797,161 are provided with force shunting entrance rails having a relatively large force shunting effect which varies as the entrance rails become worn.

When a train is in motion, there are two factors which cause considerable problems in connection with weighing. Because the rail and its support flexes due to the wheel load, the train normally moves on a lower level than the nominal level defined by the unloaded rail, and at the same time oscillations in the vertical plane are produced because of the deflection of the rail between the sleepers. When the train passes over the weighing device having a large foundation structure, the elastic properties of the rail support are changed and the train is "lifted up", because the flexing of the support is substantially reduced and the deflection between the sleepers is entirely eliminated. This causes uncontrolled changes in the ver-

tical forces if it is desired to weigh a train in motion.

This problem can be reduced if the scale foundation is extended in both directions along the track, and the foundation is gradually softened towards its ends in order to make the transition between rail on sleepers and rail on the foundation as smooth as possible.

The above clearly illustrates that foundations for a device having a good accuracy are expensive.

It is the main object of the present invention to enable elimination of the extensive and expensive weighing foundations required by known weighing devices whilst obtaining acceptable weighing accuracy, and also to eliminate, or at least mitigate, the considerable drawbacks that these foundations cause during the weighing operation itself. Furthermore, it should, with the device according to the invention, be possible to weigh either stationary vehicles or vehicles in motion, with an accuracy equal to, or exceeding the accuracy obtained with known stationary devices.

According to a first aspect of the present invention there is provided a device for weighing a rail-guided vehicle, which device comprises load sensing means adapted to be supported, in use of the device, by support means, and a vehicle supporting means which is supported by the load sensing means so that the load from the wheels of a vehicle is transferable from rails on which the vehicle is guided to the vehicle supporting means, the vehicle supporting means having two vehicle supporting portions which are adapted to extend parallel to respective rails, the vehicle supporting portions being connected for angular movement relative to one another about an axis substantially perpendicular to the vehicle supporting portions and in the plane thereof so that the vehicle supporting portions are movable, in use of the device, in accordance with movement of the support means.

According to a second aspect of the present invention there is provided a device for weighing a rail-guided vehicle, which device comprises load sensing means supported by main rails, or by a frame part supported by main rail supporting means, and a vehicle supporting means which is supported by the load sensing means so that the load from the wheels of a vehicle is transferable from the rails to the vehicle supporting means, the vehicle supporting means having two vehicle supporting portions which extend parallel to respective rails, the vehicle supporting portions being connected for angular movement relative to one another about an axis substantially perpendicular to the rails and in the plane thereof so that the vehicle supporting portions are movable in accordance with movement of the rails or the frame part.

A device according to the invention may form an integrated part of the track system and does not need a separate foundation having different elastic properties than the rest of the track system. The device is arranged so that it follows the movements of the rails and accordingly a force is exerted on the load sensing means which is independent of the flexing of the rails and the rail support.

A preferred embodiment in accordance with the invention comprises load sensing means which can accept side forces so that no tie bars are required for resisting these forces. This results in a system accuracy which is fully defined by the accuracy of the components used, and no errors are introduced during the installation. Hereby final calibration of the weighing device at the factory becomes possible, and it can be installed on site without further tests or calibrations, which considerably reduces the cost of installation and set-up and makes it possible for unqualified teams to install the device quickly.

For a better understanding of the present invention and to show how the same may be carried into effect reference will now be made, by way of example, to the accompanying drawings in which:—

FIGURE 1*a* shows a cross-section along line A—A of Figure 1*b* of a device according to the present invention,

FIGURE 1*b* shows a plan view of the device according to Figure 1*a*,

FIGURE 2*a* shows a longitudinal cross section along line A—A of Figure 2*b* of a further form of a device according to the invention,

FIGURE 2*b* shows a plan view of the device according to Figure 2*a*,

FIGURE 3*a*—*c* show, respectively, a longitudinal cross-section along line B—B of Figure 3*b*, a section along line A—A of Figure 3*a* and a plan view of part of another embodiment of the invention,

FIGURES 4*a*—*b* show, respectively, a plan view and a section along line A—A of Figure 4*a* of part of another embodiment of the invention,

FIGURE 5 shows another embodiment of the invention,

FIGURE 6*a* shows a longitudinal cross-section along line A—A of Figure 6*c* of a still further embodiment of the invention,

FIGURE 6*b* shows a cross-section showing part of the embodiment of Figure 6*a*, the section being transverse to the longitudinal section of Figure 6*a*,

FIGURE 6*c* is a plan view of the embodiment of Figure 6*a*.

Figures 1*a* and 1*b* show a weighing device according to the invention and including a

vehicle supporting means which comprises two beams 1 which are partially interconnected for relative rotational movement by a cross connection 2 and supported by load sensing devices 3 in openings 4 in the web of the main rails 8. The portions of the vehicle supporting means designed to be in contact with a vehicle wheel 5 have the same section as the main rail. The load sensing devices 3 are arranged substantially transversely of the main rails and consist in this case of load cells of shear stress sensing type in the form of rods of substantially cylindrical shape. One end of each load cell is mounted in one of the beams 1 while the other end extends through the opening 4 in the web of the rail and rests against the upper part of the lower rail flange 6. In order that the rail should be able to move in the longitudinal direction, to allow for temperature changes, for instance, one of the openings in each rail is of oval shape so that the longitudinal movements of the rail do not affect the load cells. In order to limit movement of the weighing device in the transverse direction, it is possible to arrange stop shoulders 7 on the outside of the upper surface of the lower rail flange. These stop shoulders will serve as stop surfaces for the load cells 3 and therefore limit transverse movement of the weighing device. Owing to the connection between the beams one main rail can have flexing characteristics different from the opposing main rail at the points where the weighing device is supported, so that different slopes of the rails can arise without any detrimental effect on the weighing result.

The device illustrated in Figures 2*a* and 2*b* differs from the device according to Figure 1 in that the vehicle supporting means comprises a flexible platform edge portions of which are intended to support the wheels of a vehicle. The platform is able to twist so that the edge portions thereof move relative to one another about an axis substantially perpendicular to the edge portions. Load sensing devices 3 are supported by frame parts 11 of the weighing device, which in the illustrated embodiment is arranged between the rails and connected with rail supports 10, for instance, bolts. It is of course possible to arrange the frame parts 11 outside the rails such as is illustrated by the interrupted lines in Figure 2*b*.

As shown in Figures 3*a*—*c* the frame part may comprise only one of the two opposing rail ends 8 on each rail. This device comprises, preferably, a shear stress sensing load cell of the type comprising a rod which is arranged to bend under a shear stress, one end of the rod being arranged to support a vehicle supporting rail part 1. The other end of the rod is mounted in said one rail end 8, the rod extending substantially parallel with the ground plane One advantage of this type of load cell is that the output of the load cell is essentially independent of where the force is applied, that is in this case the position of the wheel In order to protect the load cells against twisting moments caused for instance by horizontal side forces transverse to the rails, the parts 1 are connected with a transverse connection 12. However, the transverse connection 12 allows the parts 1 to move angularly relative to one another about the longitudinal axis of the connection.

The device shown in Figures 4*a*—*b* comprises a vehicle supporting means 1 in the form of a flexible platform edge portions of which are intended to support the wheels of a vehicle. The platform is able to twist so that the edge portions thereof move relative to one another about an axis substantially perpendicular to the edge portions. The frame part of the device comprises two opposing rail ends 8 on each rail. The rail ends 8 are however, reinforced and shaped so that they can carry the load sensing devices 3, which in this case are arranged parallel to the track and consist of load cells, of shear stress sensing type, in the form of rods. The two rail ends 8 are provided with a cross-section 9 in order to resist twisting torque moments caused for instance by horizontal side forces transverse to the rails. These figures also show that the device can be designed so that the vehicle supporting means, together with load cells which have malfunctioned, can be removed from the track for servicing simply by lifting the load cells straight up out of U-shaped recesses on the rail ends 8.

Figure 5 shows a device comprising a vehicle supporting means 1 in the form of a flexible platform similar to that shown in Figure 4, and a frame part 8 connected to the vehicle supporting means 1 by transition rails 13, which at their ends are provided with elastically deformable friction-free joints 14. The portion of the rails between the joints 14 does not bend substantially as the wheel of a vehicle passes thereover. The friction free joints comprise local cut-outs in the transition rails. By this arrangement joints in the rail track are avoided and a wheel has a smoother movement over the weighing device. Because of the elastically deformable friction-free joints the transition rails will take up only an insignificant force, and the vehicle supporting part can move substantially freely in the vertical direction during loading and unloading of the load cells.

Figures 6*a*—*c* show an embodiment wherein the main rails are unbroken at the weighing station and the vehicle supporting part 1, 2 is disposed between the rails. The

load is transmitted via the flanges of the vehicle wheel to a replaceable rail included in the vehicle supporting part of the weighing device and is transmitted therefrom through the load cells 3, which are shear sensing transducers of the type comprising a rod arranged to bend under a shear stress, and supported by a frame part 11 resting on a rail support 10. The replaceable rail is provided with tapered end sections 15 and a higher middle section 16 so that a wheel passing over the scale will roll up-hill on the replaceable rail with its flange and when it is on the middle section it is entirely free from the main rail and supported by the vehicle supporting part. The latter comprises two beams 1, which are rigidly connected to an I-beam 2 which permits angular movement of the beams relative to one another about an axis substantially perpendicular to the rails and in the plane thereof.

WHAT WE CLAIM IS:—

1. A device for weighing a rail-guided vehicle, which device comprises load sensing means adopted to be supported, in use of the device, by support means, and a vehicle supporting means which is supported by the load sensing means so that the load from the wheels of a vehicle is transferable from rails on which the vehicle is guided to the vehicle supporting means, the vehicle supporting means having two vehicle supporting portions which are adapted to extend parallel to respective rails, the vehicle supporting portions being connected for angular movement relative to one another about an axis substantially perpendicular to the vehicle supporting portions and in the plane thereof so that the vehicle supporting portions are movable, in use of the device, in accordance with movement of the support means.

2. A device according to Claim 1, wherein the load sensing means are supported on support means.

3. A device according to Claim 1 or 2, wherein the load sensing means comprises a shear responsive transducer having a rod which is disposed with its axis substantially parallel with the ground plane, one end portion of the rod being connected to the vehicle supporting means, and the other end portion of the rod being supported by the support means, such that the rod is subjected to shear stresses when a vehicle is supported on the vehicle supporting means.

4. A device according to Claim 3, wherein the said other end portion of the rod is received in an opening in a main rail.

5. A device according to Claim 3, wherein the said other end portion of the rod is supported by a frame part supported by means supporting main rails.

6. A device according to Claim 5, wherein the vehicle supporting means is connected to the frame part by means of transition rails end portions of which comprise frictionless elastic joints.

7. A device according to Claim 3, wherein the rod of the transducer is disposed with its longitudinal axis substantially parallel to the rails.

8. A device according to Claim 3, wherein the rod of the transducer is disposed with its longitudinal axis substantially transverse to the rails.

9. A device according to any one of the preceding Claims, wherein each vehicle supporting portion comprises a beam.

10. A device according to any one of the preceding claims, wherein each vehicle supporting portion is rigidly connected to a connecting member which, in use of the device, extends transversely of the rails.

11. A device according to any one of Claims 1 to 9, wherein the vehicle supporting portions are pivotally interconnected by a connecting member which, in use of the device, extends transversely of the rails.

12. A device according to any of the preceding claims, wherein the support means for the load sensing means are interconnected by a member disposed between the rails and transversely relative thereto, for protecting the load sensing means against twisting torque moments caused by horizontal side forces transverse to the rails.

13. A device for weighing a rail-guided vehicle, which device comprises load sensing means supported by main rails, or by a frame part supported by main rail supporting means, and a vehicle supporting means which is supported by the load sensing means so that the load from the wheels of a vehicle is transferable from the rails to the vehicle supporting means, the vehicle supporting means having two vehicle supporting portions which extend parallel to respective rails, the vehicle supporting portions being connected for angular movement relative to one another about an axis substantially perpendicular to the rails and in the plane thereof so that the vehicle supporting portions are movable in accordance with movement of the rails or the frame part.

14. A device for weighing rail-guided vehicles, substantially as hereinbefore described with reference to, and as shown in, Figures 1*a* and 1*b* of the accompanying drawings.

15. A device for weighing rail-guided vehicles, substantially as hereinbefore described with reference to, and as shown in, Figures 2*a* and 2*b* of the accompanying drawings.

16. A device for weighing rail-guided vehicles, substantially as hereinbefore described with reference to, and as shown

in, Figures 3*a*, 3*b* and 3*c* of the accompanying drawings.

17. A device for weighing rail-guided vehicles, substantially as hereinbefore described with reference to, and as shown in, Figures 4*a* and 4*b* of the accompanying drawings.

18. A device for weighing rail-guided vehicles, substantially as hereinbefore described with reference to and as shown in, Figure 5 of the accompanying drawings.

19. A device for weighing rail-guided vehicles, substantially as hereinbefore described with reference to, and as shown in, Figures 6*a*, 6*b* and 6*c* of the accompanying drawings.

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3 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheet 1

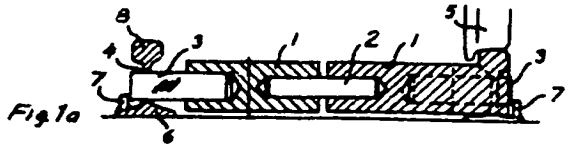

Fig.1a

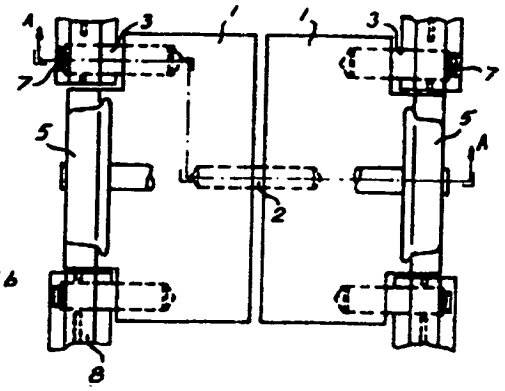

Fig.1b

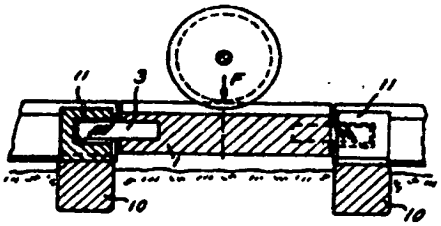

Fig.2a

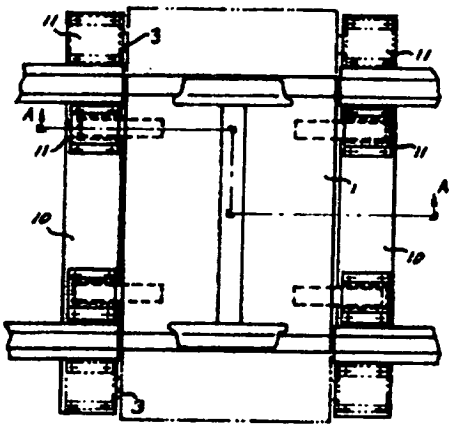

Fig.2b

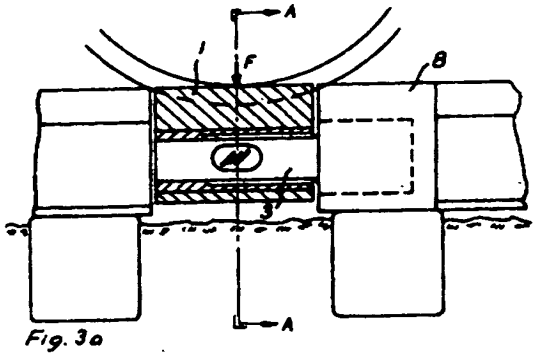

Fig. 3a

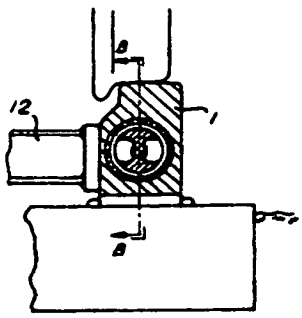

Fig. 3b

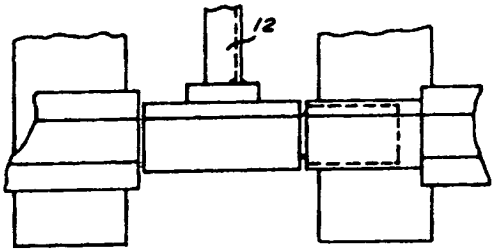

Fig. 3c

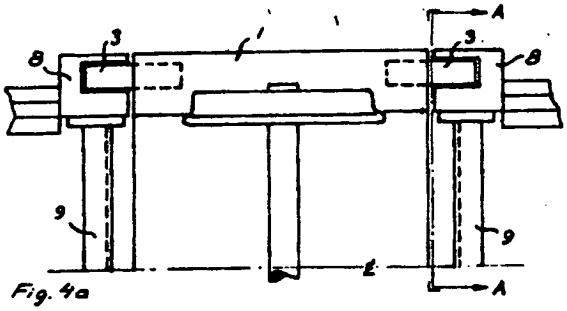

Fig. 4a

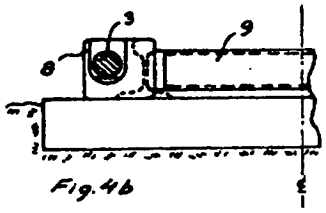

Fig. 4b

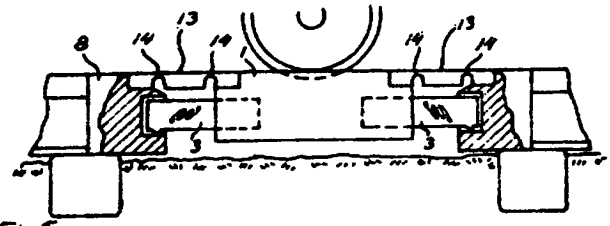

Fig. 5

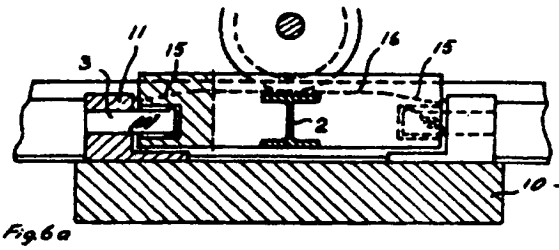

Fig. 6a

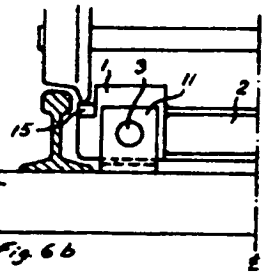

Fig. 6b

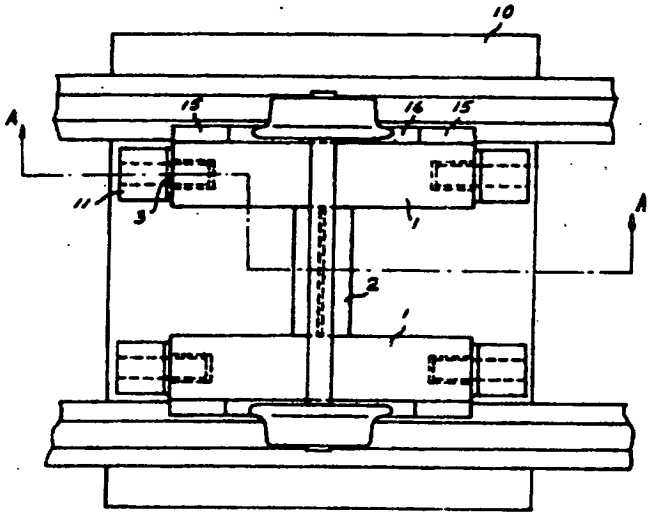

Fig. 6c

Application No: GB 0021556.6
Claims searched: 1 - 11

Examiner: Tom Sutherland
Date of search: 3 January 2001

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.S): G1W

Int Cl (Ed.7): G01G 19/04, 19/06

Other: Online: WPI, EPODOC, JAPIO

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
A	GB 2315559 A	(WEIGHWELL)	
A	GB 1463958	(TOKYO SHIBAURA DENKI)	
A	GB 1368115	(CONRAIL)	
A	GB 1368108	(TRANCON)	

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.